Department of Computer Science and Engineering
The University of Texas at Arlington

Reflection

Echo - An Interactive Mirror Controlled by an Android™ phone

Team Members:
Jacob Fisher
Sumeet Kaur
Aisha Kulindwa
Sean Nesburg
Tanmaykumar Patel

Last Updated: July 26, 2014

Table of Contents

1. Product Concept 8
1.1. Purpose and Use 8
1.2. Intended Audience 8
2. Product Description and Functional Overview 10
2.1. Features and Functions 10
2.2. External Inputs and Outputs 11
2.3. Product Interfaces 12
3. Customer Requirements 15
3.1. Android™ Control Application 15
3.2. Display Multiple Application Icons 15
3.3. Switch between Applications 15
3.4. Voice Recognition 16
3.5. “How-To” Application 16
3.6. Speakers Mounted on Echo 16
3.7. Bluetooth Connectivity 16
3.8. Pill Reminder Applet 17
3.9. Resolution and Brightness 17
3.10. Microphone 17
3.11. Power Button 17
4. Packaging Requirements 18
4.1. Mirror Housing 18
4.2. Mirror Size 18
4.3. Mirror Weight 18
4.4. Power Cable 19
5. Performance Requirements 20
5.1. Smart Phone to Mirror Synchronization Delay 20
5.2. Smart Phone Control Latency 20
5.3. Internet API Interface Latency 20

5.4. Speaker Quality 21
5.5. Microphone Quality 21
6. Safety Requirements 22
6.1. Installation 22
6.2. Packaging Safety 22
6.3. Heat Dissipation 22
7. Maintenance and Support Requirements 23
7.1. User Manual 23
7.2. Troubleshooting Guide 23
7.3. Application Updates 23
7.4. System Software Updates 24
7.5. Hardware Support & Maintenance 24
7.6. Source Code & Documentation 24
8. Other Requirements 25
8.1. Security and Privacy 25
8.2. Bluetooth range 25
8.3. Android™ Version Support 25
8.4. Moisture Control 26
9. Acceptance Requirements 27
9.1. Verify Connection to the Internet 27
9.2. Verify Smart Phone Application Functionality 27
9.3. Verify Smart Phone Bluetooth Connection with Mirror 27
9.4. Verify Smart Phone to Screen Interface 27
9.5. Verify Smart Phone Voice Recognition 28
10. Use Cases 29
10.1. Pair Phone with Echo System 29
10.2. Display an application on Echo System. 29
10.3. Play Music. 29
10.4. Play a “How-To” Video. 30
10.5. Activities using Voice Command. 30

11. Feasibility Assessment 32
11.1. Scope Analysis 32
11.2. Research 32
11.3. Technical Analysis 33
11.4. Cost Analysis 33
11.5. Resource Analysis 34
11.6. Schedule Analysis 35
12. Future Items 38
12.1. Customer Requirement 3.8: Pill Reminder Applet 38

Document Revision History

Revision Number	Revision Date	Description	Rationale
0.1	2 July 2014	First Draft	Initial draft for Echo system
0.2	11 July 2014	Document Revision	Revisions made after instructor feedback
1.0	16 July 2014	First Submission	Revisions made after peer feedback
1.1	18 July 2014	Document Revision	Revisions made after Gate Review
2.0	26 July 2014	Document Revision	Revisions made after team feedback

List of Figures

FIGURE **PAGE**

Figure 1-1 Conceptual Diagram..... 9
Figure 2-1: Preliminary mock-up of Echo Smart Mirror..... 12
Figure 2-2: Preliminary mock-up of the Android™ mobile App..... 13
Figure 10-1: Use case diagram for user and Echo system..... 31

List of Tables

TABLE **PAGE**

Table 2-1: External and Internal Inputs and Outputs 11
Table 11-1: Preliminary Cost Analysis 34
Table 11-2: Function-Point Analysis 35
Table 11-3: Adjustment Factors 36
Table 11-4: Jones' First Order Estimation 37

1. Product Concept

This section describes the purpose, use and intended user audience for Echo. Echo is a Smart Mirror that displays apps from a user's phone to a mirror. The user will be able to choose which apps to display on the mirror and enlarge the app to see it in more detail. It achieves this using an Android Control Application (ACA) that accompanies the Echo.

1.1. Purpose and Use

Echo will give a better start to the day. The few minutes that you spend in front of the mirror looking at your reflection could be used more productively. While brushing your teeth you can inquire about weather, social updates, calendar events, emails or even listen to music.

Echo is designed for the average consumer who wishes to view information more easily than their phone. The ACA will allow the user to select various apps that are on their Android™ phone. The selected apps will be displayed on the mirror and will allow the user to see updated information, similar to normal locked screen updates.

When the user wishes to see more detailed information about a certain app, the user clicks on the desired app on their phone and the app will enlarge on the mirror. To make the system more hands off, the ACA will listen for key voice commands. The commands will be in the format of "Echo ____." Where the blank will be a command.

1.2. Intended Audience

The intended user for Echo is the average consumer who needs reminders or prefers to always know what is going on. For example the forgetful husband who needs reminders for special dates, or the busy broker who wants updates immediately, or the average person who just likes seeing everything at once.

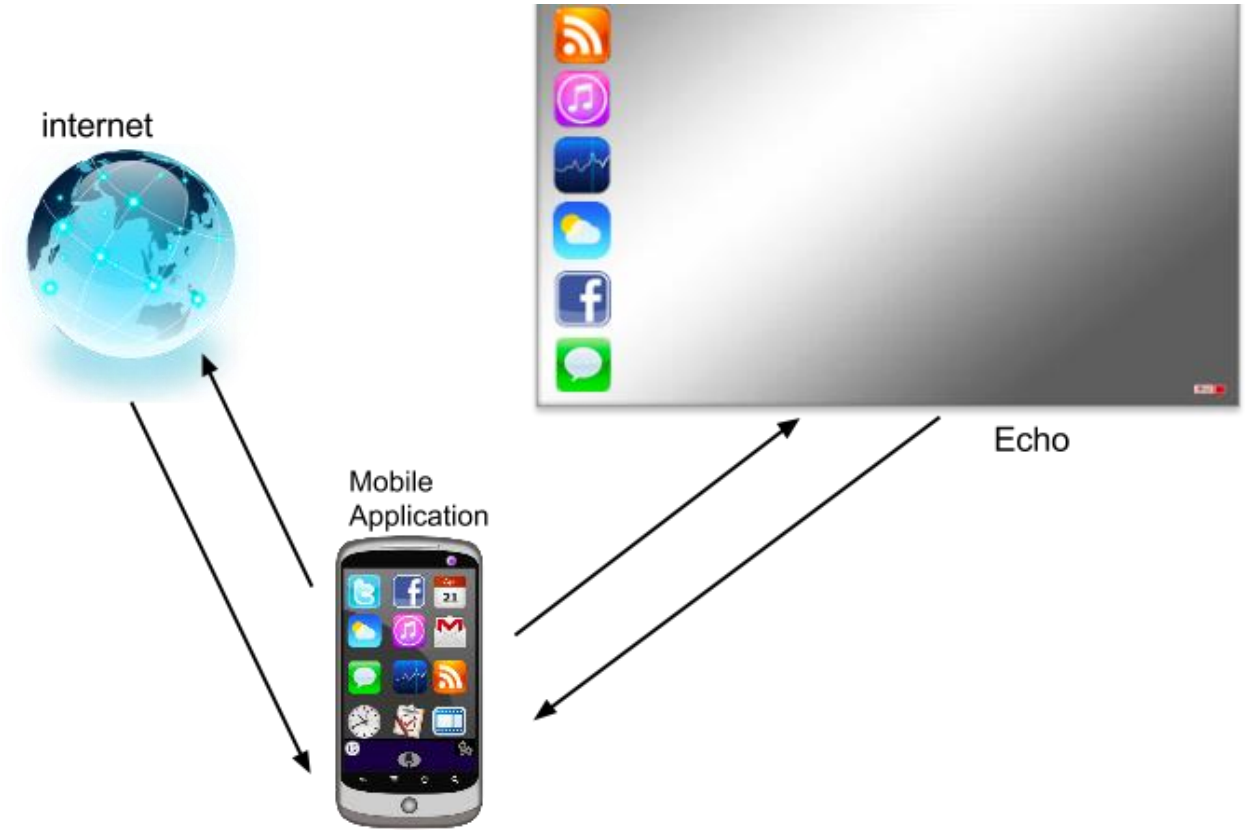

Figure 1-1 Conceptual Diagram

2. Product Description and Functional Overview

The following section provides the overview of the User Friendly Echo Smart Mirror. The primary operational aspects of the product, from the perspective of the end users, maintainers, and administrators, are defined here. The key features and functions found in the product, as well as critical user interactions and user interfaces are described in detail.

2.1. Features and Functions

Echo is a Smart Mirror that will be able to display your important information and favorite smart phone apps on a bigger screen. Echo will consist of a two-way mirror, an LED screen, single-board computer or a motherboard, and will work together with an Android™ application. The LED screen will be behind a two-way mirror that will allow the user to see sharp images when Echo is on, but also have a wonderful mirror when Echo is off. The computer motherboard will control the application display and the connectivity between the Android™ application and the mirror. All hardware will be enclosed in a rectangular wooden casing to prevent them from external damage and to give the mirror a good finished look. The Android™ application can be used to control the mirror, but the main interaction will be with a microphone in Echo.

The Android™ control application (ACA) will allow the user to select the applications they want to view on the mirror from a list of many great applications that already exist in their phone. The phone will connect to the mirror via Bluetooth™. Whenever the application in on, and Echo is within the Bluetooth™ range of the phone, Echo will display the preselected applications on the mirror.

Echo will display the applications on one side of the mirror so that the user can have free space to see him or herself clearly. Other than the preselected applications, Echo will also be able to show different “How-To” videos on one side of the mirror from a preselected list of many related videos from YouTube. The user will simply select the “How-To” icon in the ACA and then select the desired video. The user might select “How to tie a tie” or “How to style your hair,” and the application will start playing the video on Echo.

2.2. External Inputs and Outputs

Name	Type	Description	Use
Bluetooth™	Input/ Output	The connection protocol that Echo will use to communicate with the Android™ device.	Echo will get settings and other data from the Android™ device.
LED Screen	Screen Output	The applications that are selected are viewed on the screen.	The user will be able to see any important updates based on the applications that they have selected.
Application - Touch screen	Input	The smart phone touch screen used to interact with the application.	The user will be able to see the application they want to view on mirror by touching the icons on their smart phones in settings mode.
Application- Voice command	Input	Voice recognition using the phone to interact with apps	The user will be able to open specific applications and interact with them with voice command.
Echo- Voice Command	Input	Voice recognition using Echo to interact with apps	The user will be able to open specific applications and interact with them with voice command.
Speaker	Output	Producing sound for the Echo system	The user will be able listen to audio from videos and music application when activated.

Table 2-1: External and Internal Inputs and Outputs

2.3. Product Interfaces

Figure 2-1: Preliminary mock-up of Echo Smart Mirror

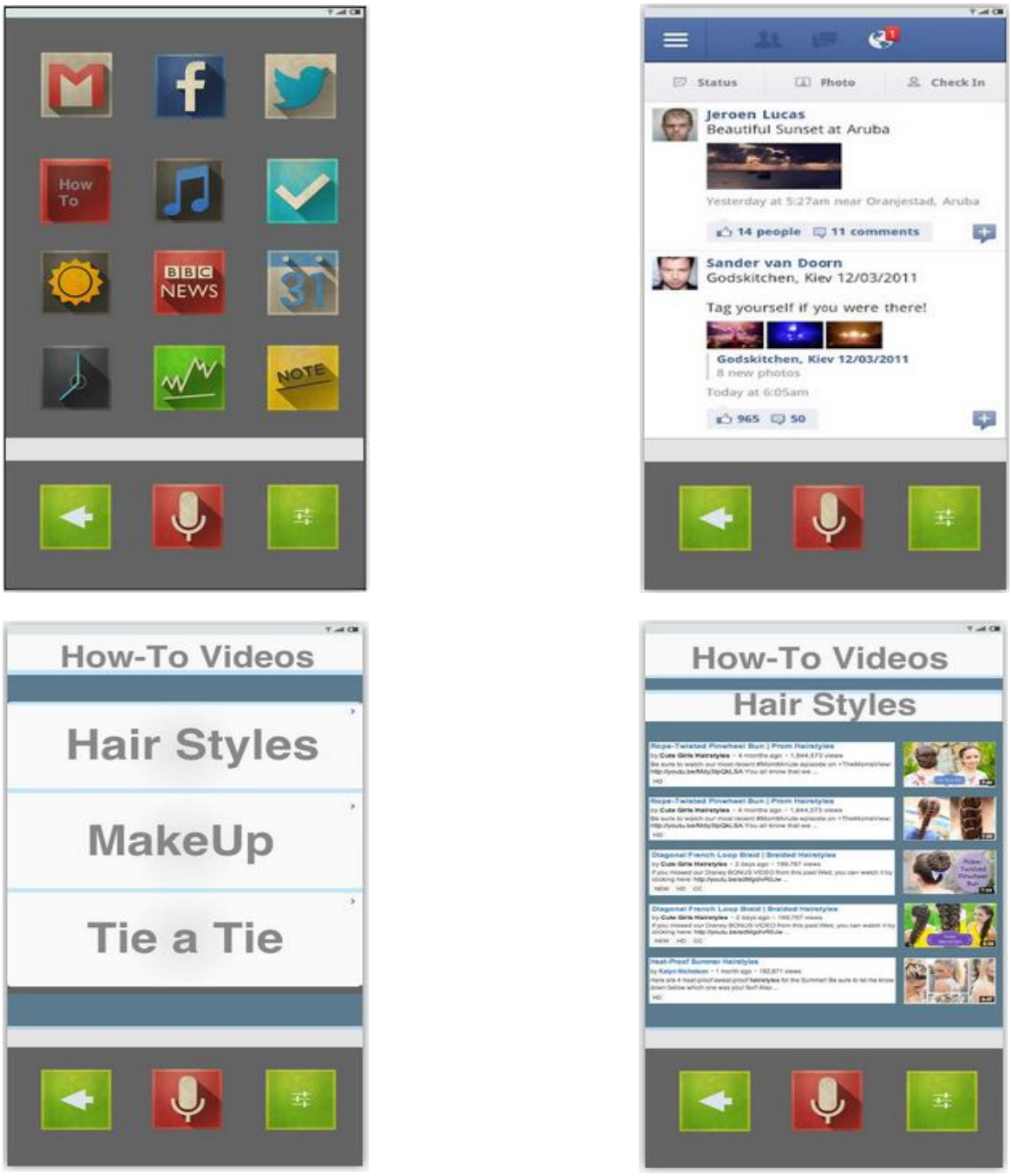

Figure 2-2: Preliminary mock-up of the Android™ mobile App

As shown in Figure 2-1, Echo Smart Mirror will display your chosen application icons on one side of the mirror. When the user opens one of the applications the icons will disappear and give room for the app to open on one side of the mirror.

Figure 2-2 shows the Android™ control application (ACA) mock-ups, where the first screen shows the home page with selected apps' icons, the back button on the bottom left, the settings button on the bottom right and the voice input button at the bottom center. The next screen shows the enlarged view of the Facebook application. The bottom left screen shows a mockup of the "how-to" application and the bottom right screen shows the list of preselected videos.

3. Customer Requirements

This section will cover the requirements that are important to our customer. Echo's main function is to allow the user to see notifications and important information from applications from his or her phone with ease. Echo will also allow the user to view "How-To" videos while still viewing their reflection.

3.1. Android™ Control Application

3.1.1. Description: It is an Android™ application that is used to control Echo system. It shall interact with other applications on the user's phone and fetch data from those applications to display on the mirror.
3.1.2. Source: Reflection
3.1.3. Constraints: Valid Internet connection, must be an Android™ device.
3.1.4. Standards: Android API
3.1.5. Priority: 1- Critical

3.2. Display Multiple Application Icons

3.2.1. Description: The Android™ Application and the mirror shall display multiple application icons on the main/opening screen. For example, Facebook, Weather, Calendar, Clock, Music and How-To app. The user can choose one of the available applications to open and display the large interface of the application on the mirror.
3.2.2. Source: Reflection
3.2.3. Constraints: Connection between the phone and Echo system.
3.2.4. Standards: None
3.2.5. Priority: 1- Critical

3.3. Switch between Applications

3.3.1. Description: The Android™ Application shall allow user to switch between the Android™ applications by either using the touch screen from phone or using voice command.
3.3.2. Source: Reflection
3.3.3. Constraints: Connection between the phone and Echo system.
3.3.4. Standards: None
3.3.5. Priority: 1- Critical

3.4. Voice Recognition

3.4.1. Description: The user can use voice commands to interact with Echo.
3.4.2. Source: Reflection
3.4.3. Constraints: The English (US) language only, proximity of the user to Echo, background noise, quality of the microphone, proximity of phone to echo.
3.4.4. Standards: None
3.4.5. Priority: 2- High

3.5. "How-To" Application

3.5.1. Description: The Android™ application associated with Echo will have an applet that allows the user to watch "How-to" videos such as "*how to tie a tie"*. This will allow the user to mimic the video while being able to see him or herself. All of the how-to videos will be preselected.
3.5.2. Source: Sponsor
3.5.3. Constraints: Internet connection on the Phone, Bluetooth connection between the phone and Echo system, and the availability of the video on YouTube.
3.5.4. Standards: Application on Android™ device.
3.5.5. Priority: 1 - Critical

3.6. Speakers Mounted on Echo

3.6.1. Description: Echo shall have speakers mounted on to it. User shall be able to hear audio for videos and music.
3.6.2. Source: Reflection
3.6.3. Constraints: Size of the product and the product casing.
3.6.4. Standards: None
3.6.5. Priority: 1 - Critical

3.7. Bluetooth Connectivity

3.7.1. Description: Phone connects to mirror via Bluetooth. All the data transfer happens via Bluetooth.
3.7.2. Source: Reflection
3.7.3. Constraints: The Bluetooth range, the line of sight between the phone and Echo.
3.7.4. Standards: Bluetooth
3.7.5. Priority: 1- Critical

3.8. Pill Reminder Applet

3.8.1. Description: The Android™ application shall come with an applet that will let the user set reminders for pills and will allow the user to upload pictures of the pills. The user will be able to see the directions as well as the pictures of the pills they need to take that day.
3.8.2. Source: Sponsor
3.8.3. Constraints: None
3.8.4. Standards: None
3.8.5. Priority: 4- Low

3.9. Resolution and Brightness

3.9.1. Description: Echo will have a high enough resolution and be bright enough so that the user will be able to see all information displayed clearly.
3.9.2. Source: Project Supervisor
3.9.3. Constraints: Brightness and resolution of the monitor. Darkness of the mirror. Brightness of the room.
3.9.4. Standards: None
3.9.5. Priority: 2- High

3.10. Microphone

3.10.1. Description: Echo will have a microphone built onto it. This will allow the user to interact with the ACA hands free.
3.10.2. Source: Reflection
3.10.3. Constraints: Placement of the mic on the casing.
3.10.4. Standards: None
3.10.5. Priority: 1 - Critical

3.11. Power Button

3.11.1. Description: Echo will have an external power button to allow the user to conserve energy and to power down the system if desired.
3.11.2. Source: Reflection
3.11.3. Constraints: None
3.11.4. Standards: None
3.11.5. Priority: 1 - Critical

4. Packaging Requirements

This section describes some of the packaging requirements that will be met for the Echo system. Echo will be a fully assembled two-way mirror enclosed within a wooden box that can easily be installed on a wall. It will come with instructions on how to download the Android™ application that will be used together with Echo. Echo needs to be connected to a power source.

4.1. Mirror Housing

4.1.1. Description: The components of Echo will be attached to the inside of the wooden housing to secure them in place. The housing will prevent any of the components from being exposed to the user. The housing will be rectangular in shape (wooden box). The housing will also have mount for the phone. The housing will keep moisture from entering Echo.

4.1.2. Source: Reflection

4.1.3. Constraints: Echo should be constructed in such a way that it can be mounted on a wall. Budget for total waterproofing.

4.1.4. Standards: None

4.1.5. Priority: 2 - High

4.2. Mirror Size

4.2.1. Description: Echo will be no larger than 44” x 24” x 8”.

4.2.2. Source: Reflection

4.2.3. Constraints: Size of the room and components.

4.2.4. Standards: None

4.2.5. Priority: 3 - Moderate

4.3. Mirror Weight

4.3.1. Description: The weight of Echo will not exceed 50 lbs.

4.3.2. Source: Reflection

4.3.3. Constraints: None

4.3.4. Standards: None

4.3.5. Priority: 3 - Moderate

4.4. Power Cable

4.4.1. Description: The cable will be used as the source of power for the Echo. The power cable can be modular.
4.4.2. Source: Reflection
4.4.3. Constraints: None
4.4.4. Standards: None
4.4.5. Priority: 1 – Critical

5. Performance Requirements

This section will describe the performance requirements of Echo. Echo's performance depends on the speed with which it synchronizes with the phone application and displays each item. Using Bluetooth technology, streaming live information to the mirror should be relatively seamless.

5.1. Smart Phone to Mirror Synchronization Delay

5.1.1. Description: There will be a small delay of 1 to 2 seconds in the reaction of the screen synchronizing with the phone.
5.1.2. Source: Reflection
5.1.3. Constraints: The synchronization time will vary depending on the smart phone used to control the system, and the processor running the mirror.
5.1.4. Standards: None
5.1.5. Priority: 3 – Moderate

5.2. Smart Phone Control Latency

5.2.1. Description: There will exist a small delay of up to a second between the input controls and the corresponding action of the mirror due to processing delay.
5.2.2. Source: Reflection
5.2.3. Constraints: Processing speed of the smart phone used to control the system and the processor running the mirror. Bluetooth™ signal.
5.2.4. Standards: None
5.2.5. Priority: 2 – High

5.3. Internet API Interface Latency

5.3.1. Description: The apps displayed on the mirror will be retrieving real time data from multiple websites. There will be a standard web service delay of on average 50-200ms delay in data query and display.
5.3.2. Source: Reflection
5.3.3. Constraints: Internet speed
5.3.4. Standards: None
5.3.5. Priority: 4 – Low

5.4. Speaker Quality

5.4.1. Description: Echo speakers must have high quality so that the user can clearly hear the system.
5.4.2. Source: Reflection
5.4.3. Constraints: System housing will muffle the quality of the speaker.
5.4.4. Standards: None
5.4.5. Priority: 2 – High

5.5. Microphone Quality

5.5.1. Description: The microphone mounted on Echo must be of high quality such that the voice commands are correctly interpreted by the system.
5.5.2. Source: Reflection
5.5.3. Constraints: Background noise will affect the quality of recorded voice.
5.5.4. Standards: None
5.5.5. Priority: 2 – High

6. Safety Requirements

This section defines the safety requirements Echo must fulfill. Safety requirements specify all of the operational characteristics of Echo that will ensure that the user will not be physically harmed.

6.1. Installation

6.1.1. Description: The system shall include adequate anchors and screws such that it can be safely secured to the wall.
6.1.2. Source: Reflection
6.1.3. Constraints: System Size & Weight
6.1.4. Standards: None
6.1.5. Priority: 1 - Critical

6.2. Packaging Safety

6.2.1. Description: The system shall be packaged such that there will be no exposed circuitry to the user.
6.2.2. Source: Reflection
6.2.3. Constraints: None
6.2.4. Standards: None
6.2.5. Priority: 1 – Critical

6.3. Heat Dissipation

6.3.1. Description: The system shall be able to dissipate the heat generated by the components of the system.
6.3.2. Source: Reflection
6.3.3. Constraints: Adequate spacing between components & cooling mechanisms.
6.3.4. Standards: None
6.3.5. Priority: 2 – High

7. Maintenance and Support Requirements

The following section details the requirements for maintaining and providing support for Echo system after its delivery.

7.1. User Manual

7.1.1. Description: The user manual will include step-by-step instructions on how to initially install the system as well as the accompanying mobile application. It will also include directions on how to use all of the features of the system.
7.1.2. Source: Reflection
7.1.3. Constraints: US-English only.
7.1.4. Standards: None
7.1.5. Priority: 1 – Critical

7.2. Troubleshooting Guide

7.2.1. Description: The system will come with a troubleshooting guide to identify some of the problems and recommend possible solutions to both hardware and software aspects of the system.
7.2.2. Source: Reflection
7.2.3. Constraints: US-English only, not all problems will be covered.
7.2.4. Standards: None
7.2.5. Priority: 1 – Critical

7.3. Application Updates

7.3.1. Description: The Android™ application accompanying Echo will receive updates to resolve bugs. The instructions will be included in the user manual.
7.3.2. Source: Reflection
7.3.3. Constraints: The phone will need to have Internet connection and appropriate amount of free space to install the updates.
7.3.4. Standards: None
7.3.5. Priority: 2 – High

7.4. System Software Updates

7.4.1. Description: Echo system will receive updates directly via the accompanying Android™ application to resolve bugs. The instructions will be included in the user manual.
7.4.2. Source: Reflection
7.4.3. Constraints: The Android™ application will need to be connected to the Internet and will also need to be connected to Echo system to transfer the update.
7.4.4. Standards: None
7.4.5. Priority: 3 – Moderate

7.5. Hardware Support & Maintenance

7.5.1. Description: The user may change any of the hardware used in Echo. All the specifics of the hardware used in the system will be included in the user manual. The instructions on replacing the hardware will be included in the troubleshooting guide.
7.5.2. Source: Reflection
7.5.3. Constraints: Basic tools and knowledge necessary to open the system and replace the hardware parts.
7.5.4. Standards: None
7.5.5. Priority: 3 – Moderate

7.6. Source Code & Documentation

7.6.1. Description: Any code written or used by the development team and any documentation for the system will be readily available for everyone to see post production.
7.6.2. Source: Reflection
7.6.3. Constraints: None.
7.6.4. Standards: None
7.6.5. Priority: 3 – Moderate

8. Other Requirements

All the requirements that did not fall directly under any of the previous sections of this document will be found here.

8.1. Security and Privacy

8.1.1. Description: When communicating via Bluetooth™ the Android™ application should ensure the security and privacy of the user information.
8.1.2. Source: Reflection
8.1.3. Constraints: None
8.1.4. Standards: None
8.1.5. Priority: 4 - Low

8.2. Bluetooth range

8.2.1. Description: The phone needs to be within the Bluetooth™ range of Echo. There should be a clear line of sight between Echo and the phone for the most stable connection.
8.2.2. Source: Reflection
8.2.3. Constraints: Range of Bluetooth™.
8.2.4. Standards: None
8.2.5. Priority: 2 - High

8.3. Android™ Version Support

8.3.1. Description: The Application shall be designed to run on all Android™ versions between 4.0.3 and 4.4.
8.3.2. Source: Reflection
8.3.3. Constraints: Limited compatibility of phones and advanced features in previous versions of Android™.
8.3.4. Standards: None
8.3.5. Priority: 1 – Critical

8.4. Moisture Control

8.4.1. Description: Echo will prevent moisture from damaging components within the system.
8.4.2. Source: Reflection
8.4.3. Constraints: Budget for waterproofing
8.4.4. Standards: None
8.4.5. Priority: 2 – High

9. Acceptance Requirements

The following are the criteria used to verify the functionality of individual subsystems within the product.

9.1. Verify Connection to the Internet

9.1.1. Requirements Addressed: Requirements 3.5 and 5.3. The phone must be able to connect to the Internet to display the "How-To" videos and display web applications such as Facebook.

9.1.2. Verification Procedure: This requirement will be verified by showing a successful connection between the system and the Internet by successfully logging into a web application.

9.2. Verify Smart Phone Application Functionality

9.2.1. Requirements Addressed: Requirements 3.1, 3.2 and 3.3. The user must be able to access the applications through the ACA interface.

9.2.2. Verification Procedure: Verification will be attained through the successful run of the ACA. It will have to successfully connect to the mirror, and show all applications available to the user, and correctly take input from the user.

9.3. Verify Smart Phone Bluetooth Connection with Mirror

9.3.1. Requirements Addressed: Requirements 3.7 and 5.1. In order for the phone and mirror applications to communicate, they must connect through the Bluetooth connection.

9.3.2. Verification Procedure: The requirement will be verified by the successful connection from the smart phone to the system mirror computer via Bluetooth.

9.4. Verify Smart Phone to Screen Interface

9.4.1. Requirements Addressed: Requirements 3.2, 3.3 and 5.2. The user must be able to easily control the mirror through the phone application.

9.4.2. Verification Procedure: This requirement will be verified by successful transmission of control signals from the phone application to Echo. Echo must then successfully receive the control signal.

9.5. Verify Smart Phone Voice Recognition

9.5.1. Requirements Addressed: Requirement 3.4. App must provide a voice recognition feature.

9.5.2. Verification Procedure: This requirement will be verified by the system successfully and accurately recognizing voice commands.

10. Use Cases

The following section will be concerned with how a user will interact with the mobile application and the system. The uses cases will assume that the Android™ application and Echo system have already been installed. Note: “This Use Case Begins With” has been abbreviated to TUCBW, “This Use Case Ends With” with TUCEW, and “Android™ Control Application” with ACA for this section.

10.1. Pair Phone with Echo System

10.1.1. Scenario: Echo system is ON. The user opens the ACA associated with Echo system and taps the “Settings” button located on main screen. The ACA displays the settings screen, after which the user taps on the “Pair with Echo” button. The ACA will then display the form requesting information for pairing, and the user will enter the information and tap “Pair” button.

10.1.2. Actor(s): User

10.1.3. TUCBW: The user opens the ACA associated with Echo system.

10.1.4. TUCEW: Echo system pairs with ACA and displays status.

10.2. Display an application on Echo System.

10.2.1. Scenario: Echo system is ON and paired with the ACA. The user goes to the main screen of the ACA and taps on the application tile he/she wishes to display on Echo system. The ACA and Echo system display the selected application. The user may scroll up/down on Echo system using ACA if the selected application permits.

10.2.2. Actor(s): User

10.2.3. TUCBW: The user taps the application on the home screen of ACA.

10.2.4. TUCEW: Echo system maximizes the selected application.

10.3. Play Music.

10.3.1. Scenario: Echo system is ON and paired with the ACA. The user goes to the main screen of the ACA and taps on the music application tile. The ACA displays the screen associated with music application and Echo system will maximize the music application. The user can then select the track he/she wishes to play, and Echo system will play it.

10.3.2. Actor(s): User

10.3.3. TUCBW: The user taps the music tile on the home screen of ACA.

10.3.4. TUCEW: Echo system plays the selected track.

10.4. Play a “How-To” Video.

10.4.1. Scenario: Echo is ON and paired with the ACA. The user goes to the main screen of the ACA and taps on the “How-To” application icon. The ACA displays the screen associated with selected application and Echo system will maximize the selected application. The user can then tap on one of the categories, and the ACA will display the screen with list of videos in that category. The user can then tap on one of the videos and Echo system will play that video.

10.4.2. Actor(s): User

10.4.3. TUCBW: The user taps the How-To tile on the home screen of ACA.

10.4.4. TUCEW: Echo system plays the selected “How-To” video.

10.5. Activities using Voice Command.

10.5.1. Scenario: Echo system is ON and paired with the ACA. The user goes to the main screen of the ACA and taps on the “Voice Command” button and speaks into the Phone microphone one of the following commands (“Echo Select *Application name*”, “Echo Go to Home Screen”, “Echo Shut Down”, “Echo Go to Settings”). The user may also use the mic on the Echo system, if he/she is close enough, to interact with Echo in the same manner as the phone mic. The ACA displays the screen associated with the command and Echo system will do the same.

10.5.2. Actor(s): User

10.5.3. TUCBW: The user taps the “Voice Command” button on the home screen of ACA, or the user speaks the command word to the mic located on Echo.

10.5.4. TUCEW: Echo system and the ACA perform the action associated with the voice command.

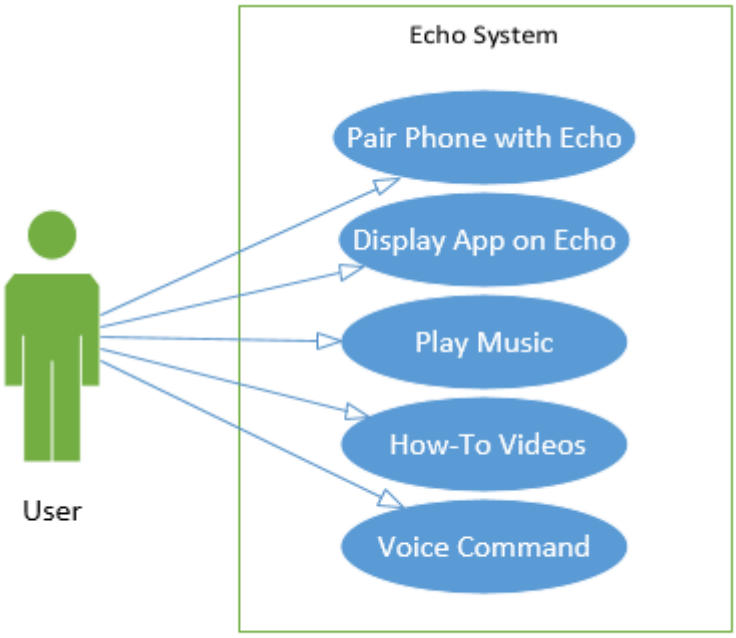

Figure 10-1: Use case diagram for user and Echo system

11. Feasibility Assessment

This section provides a feasibility assessment of the project that is entirely based upon the judgment of the team's knowledge and their experiences with similar projects. It is broken down into six parts: scope analysis, research, technical analysis, cost analysis, resource analysis, and schedule analysis.

11.1. Scope Analysis

The scope of work required for the critical requirements provided in this document is reasonable for the project's given time frame, and prototyping of said requirements by the given deadline seems feasible. We are able to come to this conclusion based on experience with the technologies that will be used and comparing other projects that have used similar technologies. Echo will support only one user at a time in order to keep things simple. The critical requirements involve displaying smart phone application to the mirror, in addition to that, Echo will also display a list of related "How-To" videos that a user can select from. All requirements will be sorted by priority and addressed from highest to lowest. Processing the requirements in this way will ensure that the more critical features get implemented first and the less critical features later.

11.2. Research

The development team has reviewed projects similar to ours, and has found that in order to create a solid product we must gain more knowledge on Android™ content sharing. We found that we have many choices on which micro-controllers we may use. The two that we have researched on are the Raspberry Pi and a regular motherboard. Further research on both of these topics is imperative to the completion of our project because they make up its backbone.

Research of the hardware design has shown that the project will need a micro-controller or a motherboard, an external infrared camera, an LED screen, Bluetooth™ transmitter, and a power supply. These hardware components will be top priority in order to make a worthwhile product.

The next highest priority in research is the development of the Android™ application. We have had very little exposure to the Android™ SDK and our project relies extensively on the communication between the application and Echo. We will need to take a closer look at not only the Android™ environment but also the Bluetooth™ limitations in order to bring both devices together.

11.3. Technical Analysis

Echo is divided into two major components, the Android™ Application and the hardware, which includes microprocessor with several hardware peripherals. In order to complete these two major components our team members will have to get more experience and knowledge on Android™ application building and research more on the micro-controller and motherboard.

The Android™ application will support only mobile devices running Android™ version 4.0.3 or greater. The development team will focus on making the application for Android smart phones although it might be used on tablets as well. The application will act as a remote for Echo. It will allow the user to turn the mirror off and on and also select the applications they want to display on the mirror. The user will also be able to use simple voice commands to open apps when the Android™ application is on. Changes made using the application will be transferred to the mirror where they will be stored locally.

11.4. Cost Analysis

Through research and experience of team members, we found that the cost of the project will be within the budget. The project is moderately hardware-driven; it requires the team to use more than just a mini motherboard or a mini computer. Echo will also need several peripherals but will not require us to create our own hardware.

Below is a preliminary breakdown of the parts and their relative prices. Some assumptions were made on the make and the model of the parts but different varieties of the item will have similar prices. The price estimated was based on the upper bound of the cost ranges to avoid underestimation.

We have some flexibility with the materials listed above and we can opt to use similar material from past projects. However because of concerns with inconsistency with our product we decided to include them in our cost estimate.

Parts	Cost
Mini Motherboard	$70.00
40’’ led screen	$400.00
2Ghz Dual core processor	$60.00
43” x 24” two way mirror	$60.00
Wooden Frame	$50.00
100 GB hard drive	$40.00
2GB RAM	$40.00
Bluetooth dongle	$10.00
Microphone	$35.00
Total Cost	$765.00

Table 11-1: Preliminary Cost Analysis

11.5. Resource Analysis

Since this project is divided into two major sections, hardware and software, we allocated our team members accordingly. We have two Computer Engineering majors, two Computer Science majors and one Software Engineering major. By examining our strengths and our weaknesses we assigned preliminary tasks to team members accordingly at every stage of development. These tasks are subject to change as we approach the final stages of our project.

The hardware portion of the project will be handled by the Computer Engineering majors because of their experience on working with similar technology. They will be mainly working with the physical peripherals and making sure that the parts can communicate with each other. They will also get help on researching new technology from the other members, but they will make the final decision on everything regarding hardware. The Software Engineering major will be in charge of the Android™ mobile application. Because the software portion of the system needs a lot of researching to find the best and efficient ways to implement our requirements, the rest of the group will be working on it to produce the best software. For every new change or risk that will be foreseen, the Computer Science majors will be assigned to it. They will also focus on the software system for Echo. The Computer Science majors will work closely with the Computer Engineers on the functionality of the device, and with the Software Engineer on the mobile application.

The team's strengths consist of great communication, some hardware experience, and great programming experience in Python, Java, and C. We are fast learners and will tackle the tasks that need to be done.

Some weaknesses the team has identified that may be of concern to the project are lack of hardware to software communication experience, that is working with Bluetooth communication, limited experience on the hardware technology needed, and limited experience with Android™ development. These three weaknesses are very concerning, but we believe that we are competent enough to learn these technologies and create a functioning product.

11.6. Schedule Analysis

Our team used three methods to estimate the approximate length of the project. The first method we decided to use was Jones' First Order Estimation.

Function Type	**Low Complexity**	**Medium Complexity**	**High Complexity**
Number of inputs	9 x 3	0 x 4	0 x 6
Number of outputs	9 x 4	0 x 5	0 x 7
Inquiries	1 x 3	0 x 4	1 x 6
Logical internal files	0 x 7	2 x 10	0 x 15
External interface files	9 x 5	0 x 7	0 x 10
Unadjusted function-point total			137

Table 11-2: Function-Point Analysis

Table 11-2 shows the various function types and the analysis of our project with respect to each type. Our unadjusted function-point total came out to 137. The majority of our function-points come from the number of input and output, and external interface files. Next we are going to compute the influence multiplier. The degree of influence is between 0 and 5 for each Adjustment Factor. A value of 0 means that the Adjustment Factor has no influence on our project; while a value of 5 means that the Adjustment Factor has a significant degree of influence on our project.

Adjustment factor	Degree of Influence (0-5)
Data Communication	4
Distributed Data Processing	3
Performance	2
Heavily Used Configuration	1
Transaction Rate	4
On-line Data Entry	5
End-User Efficiency	5
On-line Update	0
Complex Processing	1
Reusability	2
Installation Ease	1
Operational Ease	3
Multiple Sites	1
Facilitate Change	4
Sum	36

Table 11-3: Adjustment Factors

We calculated an Adjustment Factor total of 36 by summing up the degree of influence for each Adjustment Factor shown in table 11-3. Using the Adjustment Factor total, we then computed an influence multiplier:

Influence Multiplier = (36 * .01) + .65 = 1.01

Multiplying the Influence Multiplier by our Unadjusted Function Point total, we obtained our Adjusted Function Point total.

Adjusted Function Point Total = 1.01* 137 = 138.37

With our adjusted function-point total, we can now perform the Jones' First Order Estimation. We believe our project falls under the "Shrink-wrap". The classification of "Shrink-wrap" was chosen

because we are developing a mobile app and the Worst in class classification was chosen because our team's capabilities in mobile development are rather primitive. With these classifications, we calculated the duration of 9.19 calendar months for the project as seen below.

Duration = $138.37^{0.45}$ = 9.19 Calendar Months

	Best Case	Average Case	Worst Case
Adjusted Function Point	$138.37^{0.39}$	$138.37^{0.42}$	$138.37^{0.45}$
Totals	6.83	7.93	9.19

Table 11-4: Jones' First Order Estimation

The data in Table 11-4 shows that at our very best the project will take approximately 7 months to Complete and this can stretch to 9 months.

Next we are going to use the rule of thumb. We are going to consider that each member spends 25 hrs. a week on the project, and these amounts to 4.16 personal month.

Schedule time = 3.0 x man-month$^{1/3}$

Schedule time = 3.0 x $4.16^{1/3}$

Schedule time = 4.83 calendar month.

Using the rule of thumb the schedule fits perfectly with our time duration. Because of the big difference between the two methods used above, we considered one more method to find the averaged out schedule.

The last estimation model we used was the Sanity Test (Weiss & Wysocki). We used this model to average out the duration time. We used an optimistic duration of 4.83 month from the best case of rule of thumb method, nominal duration of 6.83 months from the best case of Jones' First Order Estimation method, and pessimistic duration of 9.19 month from the worst-case of the Jones' First Order Estimation method.

$$E = O + 4M + P / 6$$

$$E = (4.83 + 4(6.93) + 9.19) / 6 = 6.95\ M$$

The sanity test indicates that the project will take a total of 6.95 months. With this schedule we will be able to finish all of the critical and high priority requirements and most of the acceptance requirements.

12. Future Items

All of the requirements listed below will be implemented as time and schedule permit.

12.1. Customer Requirement 3.8: Pill Reminder Applet

12.1.1. Description: The Android™ application shall come with an applet that will let the user set reminders for pills and will allow the user to upload pictures of the pills. The user will be able to see the directions as well as the pictures of the pills they need to take that day.

12.1.2. Constraints: We do not have enough time to implement this requirement. We want to implement other customer requirements first.